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OHD L-36
METHOD OF TEST FOR
RETAINED STRENGTH OF BITUMINOUS PAVING MIXTURES

1. **SCOPE.**

   a. This method contains procedures for determining the retained strength of bituminous mixtures, laboratory or plant-produced, or roadway cores.

   b. The retained strength is determined by comparing the tensile strength of conditioned specimens with control specimens.

2. **APPARATUS.** The apparatus shall consist of the following:

   a. **Oven,** capable of maintaining a temperature of 250° ± 5° F (121°± 3°C).

   b. **Oven,** capable of maintaining a temperature of 325° ± 5° F (163° ± 3°C).

   c. **Vacuum Pump or Water Aspirator,** capable of producing a minimum pressure drop of 20 inches of mercury.

   d. **Vacuum Chamber,** suitable for subjecting specimens to vacuum saturation.

   e. **Freezer,** capable of maintaining a temperature of 0° ± 5° F (-18° ± 3°C) .

   f. **Water Bath,** capable of maintaining a temperature of 140° ± 5° F (60° ± 3°C).

   g. **Water Bath,** capable of maintaining a temperature of 77° ± 1° F (25° ± 0.6°C).

   h. **Compression Testing Machine,** shall be capable of maintaining a controlled vertical deformation rate of 0.065 ± 0.005 inch (1.65 ± 0.13mm) per minute and a minimum capacity of 10,000 pounds (4.535 metric tons).

   i. **Scale,** graduated in hundredths of an inch.

   j. **Stainless Steel Pans.**

   k. **Balance,** minimum capacity of 4,000 grams and readability of 0.1 gram.

   l. **Timer(s)**, accurate to nearest minute.

   m. **Loading Strips (Optional)**, if used, they should be made of steel with a concave surface having a radius of curvature equal to the nominal radius of the test specimen.

      i. Specimens having a 4 inch (10 cm) diameter require loading strips to be 0.5 inches (13mm) wide.

   n. **Calipers (Optional)**, if used, shall be capable of measuring specimen height to nearest 0.01 inch (0.1mm).

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3. **PREPARATION OF ANTI-STRIP AGENT.** The anti-strip agent, if required, shall be mixed with the asphalt cement at the proposed rate and maintained at a temperature of 280° ± 5° F (138° ± 3°C) for seventy-two (72) hours prior to mixing with the job aggregate. If no rate is proposed, the anti-strip agent shall be mixed at the rate of 0.5% by weight of the asphalt cement.

4. **SPECIMEN PREPARATION.**

a. **Roadway Cores.** A minimum of nine (9) roadway cores shall be taken within a few feet of each other along the same longitudinal alignment. Roadway cores shall be air-dried a minimum of 48 hours prior to testing.

b. **Laboratory Mixtures.** Aggregates blended at the job mix formula percentages and the asphalt cement shall be heated to 325° ± 5° F (163° ± 3°C) in a mechanical convection oven. The aggregate and asphalt shall be combined at the job mix formula percentage and mixed until the aggregate is thoroughly coated. A mechanical mixer is recommended. A minimum of nine (9) specimens is required.

c. **Plant-Produced Mixes.** Mix shall be heated in a 250° ± 5° F (121° ± 3°C) oven until it can be split or quartered to provide a minimum of nine (9) specimens.

d. Place the mixture in a mechanical convection oven at 250° ± 5° F (121° ± 3°C) for a minimum of one and one-half (1 ½) hours prior to compaction. The mixtures shall be compacted in accordance with OHD L-8 with the following exception:

i. The end point stress and the consolidation stress shall be adjusted to yield the required air voids in the compacted specimen.

e. Determine the Bulk Specific Gravity of each specimen according to AASHTO T 166, Method B. Compute the maximum theoretical specific gravity for the mix or determine the maximum specific gravity according to AASHTO T 209. Compute the air voids or determine air voids according to AASHTO T 269 for each specimen and the average air voids for the set of specimens. The required air voids are as follows:

MIX TYPE	REQUIRED AIR VOIDS	SET DEVIATION	SPECIMEN DEVIATION
Asphalt Concrete	6%	±1%	±2%
Bituminous Base	8%	±1%	±2%

Discard any specimen or set which does not comply with the above requirement.

f. Separate the specimens into a control group and a preconditioned group. The average air voids of each group should be approximately equal. The control group should contain the specimens whose air voids are furthest from the average. One to two or more specimens should be assigned to the preconditioned group rather than the control group.

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g. Measure or compute the height or thickness of each specimen according to ASTM D 3549 and record.

5. **PRECONDITIONING.**

a. The dry control group will be stored at room temperature until testing. The specimens shall be wrapped with plastic or placed into heavy duty leakproof plastic bags. The specimens may then be placed into 77° ± 1° F (25° ± 0.6°C) water bath for a minimum of 2 hours and then tested as described in Section 6.

b. Compute the volume of air voids for the specimen. Place the specimens to be preconditioned in a vacuum chamber containing enough water to cover specimens a minimum of 1 inch (2.5cm) and subject to a partial vacuum of 10 to 26 inches of mercury (34 to 88 kPa). The amount of time to vacuum saturate the specimens will vary depending on mix type and material used. Remove one specimen from the vacuum chamber and determine its saturated surface dry (SSD) weight according to AASHTO T 166. Place the specimen back in the vacuum chamber. Repeat procedure for each specimen in the group. Compare the SSD weight of specimens before and after vacuum saturation. The difference is the weight of the absorbed water. Calculate the volume of absorbed water. Determine degree of saturation by comparing the volume of absorbed water with the volume of air voids. If the degree of saturation is less than 55%, subject the specimen to further vacuum saturation. If the degree of saturation is greater than 80%, discard the specimen as damaged. If the degree of saturation is between 55% and 80%, remove the specimen(s) from the vacuum chamber and place in a pan with sufficient water to cover specimen(s).

c. The vacuum saturated specimens, in surface damp condition, shall then be covered tightly with plastic wrap which shall be taped securely. Sealable plastic bags may be used. Place the preconditioned specimens in a 0° ± 5°F (-18° ± 3°C) freezer for a minimum of 16 hours. Remove the plastic wrap and place the preconditioned specimens in a 140° ± 2° F (60° ± 1°C) water bath for 24 ± 1 hour. Remove preconditioned specimens and place in a 77° ± 1°F (25° ± 0.6°C) water bath. Add ice, if necessary, to adjust water bath temperature to 77° ± 1°F (25° ± 0.6°C) within fifteen (15) minutes. Maintain at this temperature for 2 ± 1 hours. Test the specimens as described in Section 6.

6. **TESTING.**

a. Allow compression machine to run for approximately 30 minutes prior to setting vertical deformation rate to 0.065 ± 0.005 inch (1.65 ± 0.1mm) per minute in a no-load condition. Set the vertical deformation rate to 0.065 ± 0.005 inch (1.65 ± 0.1mm) per minute in a no-load condition. Check vertical deformation rate in a no-load condition after each specimen and adjust if necessary.

i. Method A - Steel Loading Strips Used:
Place and center a specimen under the loading strips of the compression machine and proceed quickly with diametrical loading. Record the maximum compressive load. Continue loading until the specimen breaks (enough to pull apart by hand after the vertical crack appears). Record the severity of stripping as: none, few (about 5% or less of the broken surface) or many (more than 5%).

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ii. Method B - Steel Loading Strips Not Used:
Place and center a specimen under the flat loading head of the compression machine and proceed quickly with diametrical loading. Record the maximum compressive load. Immediately decrease the load to zero, remove the specimen and measure side flattening. The flattened edge can be marked with chalk or keel to make measuring easier. Measure the average width of the top and bottom to the nearest 0.01 inch (0.1mm) and record the average to the nearest 0.01 inch (0.1mm). Place the specimen back into the testing machine and load until a vertical crack appears. Pull the specimen apart and record the severity of stripping as: none, few (about 5% or less of the broken surface) or many (more than 5%)

7. **CALCULATIONS.**

a. Method A (with loading strips) - Calculate each specimen's tensile strength as follows:

$$S_t = \frac{P}{2\,\pi\,t}$$

Where:

S_t	=	tensile strength, psi,
P	=	maximum compressive load, pounds, and
t	=	specimen thickness, inches (4 inch diameter specimen).

b. Method B (no loading strips) - Calculate each specimen's tensile strength as follows:

$$S_t = \frac{S_{10}P}{10000\,t}$$

Where:

S_t	=	tensile strength, psi,
S_{10}	=	flattening correction,
P	=	maximum compressive load, pounds, and
t	=	specimen thickness, inches.

$$S_{10} = 1591 + 437A - 1889A^2 + 2854A^3 - 2474A^4 + 885A^5$$

Where:

A	=	Flattened width, inches.

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Or, determine S_{10} by the following table similar to AASHTO T-283 Table 1:

Width of Flattened Area, in inches	Width of Flattened Area, in cm.	Maximum Tensile Stress, S_{10}, psi	Maximum Tensile Stress, S_{10}, kPa
0	0	1640	11,308
0.1	0.25	1629	11,232
0.2	0.51	1619	11,163
0.3	0.76	1606	11,073
0.4	1.02	1595	10,998
0.5	1.27	1571	10,832
0.6	1.52	1540	10,618
0.7	1.78	1508	10,398
0.8	2.03	1470	10,136
0.9	2.29	1438	9915
1.0	2.54	1405	9687

c. Calculate the average S_t for each group. Calculate the retained strength to the nearest whole percent as follows:

$$Retained\ Strength = \frac{S_t\,(Preconditioned)}{S_t\,(Control)} \times 100$$

8. **REPORT.** Report the retained strength value and observed stripping.